

Ergonomic Analysis of Environmental Conditions in Garment Manufacturing Industries in Bengaluru, India

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Abstract: India has carved a name for itself as a globally renowned garment manufacturing center for its durability, quality and beauty. The textile and garment industry contributes about 14% to industrial production, 5% to GDP and 11% to the country's export earnings. This sector also provides employment to about 45 million people. However, various studies quote that India's success in the global garments market has been at the cost of the basic rights of labor force especially the females and migrants. Karnataka is a major apparel sourcing destination for the global market. The garment industries in Karnataka are concentrated mostly in Bengaluru where some of the largest export houses of the country exist. From the systematic review of literature and interactions with the industry experts, it was understood that the work environment in a majority of the garment manufacturing industries is unsafe and unhealthy. The workstations are poorly designed with unsuitable furniture, lack of ventilation, inappropriate lighting, and excessive noise. This poor working environment adversely influences the performance of the workers which in turn reduces the productivity of the manufacturing units. This work deliberates on the environmental audit carried out in several sections of the garment industry to see if the working environment is favorable to the workers. Environmental parameters such as noise level, illumination and temperature were measured using instruments such as sound level meter, luxmeter and hand held thermometer and were compared against OSHA (Occupational Safety and Health Administration) standards. The study revealed that the workstations were designed with congested work area, poor illumination, high temperature, improper ventilation. Hence appropriate intervention strategies have been suggested to improve health, safety and comfort of people in the working environment.

Keywords: *Work environment, Garment manufacturing industry, Ergonomics, Temperature, Illumination, Noise level, Health problems.*

INTRODUCTION

The garment industry in India comprises of both domestic and export markets. The industry is extremely fragmented with an estimated 27000 domestic manufacturers and 48000 fabricators and 1000 manufacturer – exporters. It is one of the earliest industries to come into existence. The textile industry currently contributes about 14% to industrial production, 5% to GDP and 11% to the country's export earnings [1].

Garment industries in Bengaluru started from the period of British. M/s. Bangalore dressmaking Co. was the first unit, started to manufacture garments in Bengaluru during 1940, which was started by Mr. Vittal Rao [2]. Most of garment industries are located in Bommanahalli and Peenya. The Garment industry comprises of several functional divisions such as cutting, sewing, finishing, ironing and packing. The work environment in the garment industry plays a vital role in increasing the productivity and well-being of the workers. Lighting, noise and temperature are some of the important parameters which employees are exposed to in the garment manufacturing units. The above mentioned environmental parameters have a great influence on the health, comfort and performance of the workers.

Absence of environmental factors as per the regulatory standards can lead to eye strain, headache, dizziness, heat stress, heat cramps, heat burns, heat exhaustion, heat stroke and other such illness for the workers. This can result in employee absenteeism, increased

employee turn-over and decrease in performance levels. In the above context the authors have undertaken an effort to study and analyze the environmental conditions in garment manufacturing units in Bengaluru.

LITERATURE REVIEW

Relevant literature was reviewed to gain insight into the research carried out in garment manufacturing units from human factors perspective both at international and national levels.

Bridger R.S, (2003), defines Ergonomics as the study of work. It makes the work easier. Ergonomics is more concerned with making the workplace as efficient, safe and comfortable as possible [3]. K.C. Parsons (2000) conducted a review of the principles, methods and models used in environmental ergonomics in terms of the effects of heat and cold, vibration, noise and light on the health, comfort and performance of people [4]. Sarder MD B, Sheik. N and Mandahaw (2006) conducted the study in an export garment manufacturing plant in South East Asia to evaluate the poor working conditions and its effects on the garment workers [5].

S Calvin, B Joseph, (2006) identified the common occupational related accidents that occurred in the garment industry in Bangalore [6]. P. Parimalam, N. Kamalamma, A. K. Ganguli (2006) suggested some of the ergonomic interventions to improve work environment in garment manufacturing units [7]. Padmini D.S, et al. (2012), found that the work environment in garment industries in Tirupur is unsafe and unhealthy and the workers were exposed to dust, chemicals mainly in the form of solvents, ergonomical problems, psycho social problems etc.[8]. Rena Mehta (2012) has identified the major health risk factors prevailing in garment manufacturing units of Jaipur [9]. Jose J. Canas, Boris B. Velichkovsky and Boris M. Velichkovsky (2013) defines macro ergonomics as a branch of human factors and ergonomics based on system approach which considers the organizational and sociotechnical context of work activities and process [10].

IN INDIA THE FOCUS IS PRIMARILY ON UNDERSTANDING THE OCCUPATIONAL HEALTH ISSUES IN THE AREA OF PHYSICAL ERGONOMICS. THIS MOTIVATED AUTHORS TO CONDUCT ERGONOMIC ANALYSIS OF ENVIRONMENTAL CONDITIONS IN GARMENT MANUFACTURING UNITS IN BENGALURU

METHODOLOGY

In continuation to literature review environmental audit was conducted in two garment manufacturing industries (100% EOU) in Bengaluru. Detailed process in garment manufacturing units was mapped. It was observed that 80% of the total work force employed by any typical garment manufacturing unit is housed in the cutting, sewing and finishing sections. Hence those three departments were considered for the study. The environment parameters such as temperature, illumination and noise level were measured using hand held thermometer, lux meter and sound level meter respectively. Measurements were recorded in the morning, afternoon and evening with duration of 2 hours between consecutive measurements. The points for measurement are near the window (partly daylight), center of the half depth of space (mostly artificial lighting) and farthest from the window (completely artificial lighting). The data collected was then analyzed and compared with the Occupational Health and Safety (OSHA) standards [11, 12, 13]. Based on the results appropriate interventions are suggested.

RESULTS AND DISCUSSION

The observations were tabulated and analyzed section wise to understand the environmental status prevailing in the units considered for the study.

Cutting section: The details of work environment parameters in cutting section are shown in the **Table 1** and **2**. The temperature in the cutting section ranged from 25°C to 30.1°C with a mean of 27.25°C which about 3°C higher than the OSHA recommended permissible heat exposure for continuous heavy work of 25°C [11]. The illumination levels ranged from 230 lux to 270 lux with a mean of 245.5 lux. According to Energy efficiency guide for industry in Asia, the illumination between 500 lux to 1000 lux gives

satisfaction to the workers [12]. So, the illumination levels are very poor. The noise level ranged from 83 dBA to 87.7 dBA with a mean of 84.8 dBA and is within the permissible limit of 100 dBA recommended by OSHA [13].

Table 1: Work environment parameters measured in cutting section

Location	Temperature (°C)					Illumination (lux)					Noise level (dBA)				
	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm
Near the window	25	26	28.5	27	25.4	250	265	270	268	247	84.3	85	83	83.1	83
Centre of the half depth of space	26	28	29.7	26.5	25	236	242	258	243	232	86.8	85.4	87	83.2	87
Furthest from the window	28	29.5	30.1	27	27	233	237	239	232	230	87.7	85.2	84.5	83	84

Table 2: Details of work environment and standards

Parameters	Range	Mean	OSHA Standards
Temperature (°C)	25 – 30.1	27.25	25
Illumination (lux)	230 – 270	245.5	500-1000
Noise (dBA)	83 – 87.7	84.8	100

Sewing section: The details of work environment parameters in sewing section are shown in the **Table 3** and **4**. The temperature in the sewing section ranged from 25°C to 35°C with a mean of 30°C, which is 5°C higher than OSHA recommended permissible levels [11]. The illumination levels ranged from 558 lux to 1186 lux with a mean of 598 lux. According to Energy efficiency guide for industry in Asia, the illumination between 500 lux to 1000 lux gives satisfaction to the workers [12]. The noise level ranged from 83 dBA to 83.9 dBA with a mean of 83.3 and is within the permissible limit of 100 dBA recommended by OSHA [13].

Table 3: Work environment parameters measured in sewing section

Location	Temperature (°C)					Illumination (lux)					Noise level (dBA)				
	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm
Near the window	26	27	31	30	25	750	834	1186	924	748	83	83.5	83.7	83.9	83
Centre of the half depth of space	28	30	32	31	28	432	502	594	686	427	83.8	83.4	83.2	83.5	83.5
Furthest from the window	31	32	35	33	30	360	375	392	401	358	83	83.2	83.8	83.3	83

Table 4: Details of work environment and standards

Parameters	Range	Mean	OSHA standards
Temperature (°C)	25 – 35	30	25
Illumination (lux)	358 – 1186	598	500-1000
Noise (dBA)	83 - 83.9	83.3	100

Finishing section: The details of work environment parameters in finishing section are shown in the **Table 5** and **6**. The temperature in the finishing section ranged from 22°C to 24°C with a mean of 23.02°C. According to the OSHA technical manual the permissible heat exposure for continuous moderate work is 26.7°C [11]. Hence the temperature measured was within the permissible range. The illumination levels ranged from 220 lux to 396 lux with a mean of 310.33 lux. This observation is also satisfactory as the existing level falls within the range specified by Energy efficiency guide for industry in Asia, which states that the illumination between 250 lux to 500 lux gives satisfaction to the workers [12]. The noise level ranged from 76 dBA to 79.4 dBA with a mean of 77.84 dBA and is within the permissible limit of 100 dBA recommended by OSHA [13].

Table 5: Work environment parameters measured in finishing section.

Location	Temperature (°C)					Illumination (lux)					Noise level (dBA)				
	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm	10am	12pm	2pm	4pm	6pm
Near the window	22.5	23.5	24	23	22	250	332	396	382	347	79.4	79	78.4	78.5	78
Centre of the half depth of space	22.5	23	24	23.5	22.3	336	358	389	320	334	78	77.5	77.5	78.5	78.5
Farthest from the window	22.5	23	23.5	23.5	22.5	224	253	268	246	220	78.5	77.5	76	76	76.3

Table 6: Details of work environment and standards

Parameters	Range	Mean	OSHA Standards
Temperature (°C)	22 – 24	23.02	26.7
Illumination (lux)	220 – 396	310.33	250-500
Noise (dBA)	76 – 79.4	77.84	100

Analysis of the audit results reveals that the temperature was high in cutting and sewing sections. This can be attributed to climatic conditions, workplace heat exposures and bad design of the work layout itself. The illumination level was poor in almost all the sections and the noise level was found to be within the recommended level as per OSHA standards. Hence appropriate intervention strategies have been suggested (Table 7) based on the extensive literature review conducted to improve environmental conditions in the units considered. This will have a positive influence on health, safety, comfort and performance of the employees.

Table 7: Suggestive Interventions

Observation	Interventions
The illumination level was poor in cutting, sewing and finishing sections and it was below the recommended level as per the Energy Efficiency Guide for Garment Industry in Asia.	<ul style="list-style-type: none"> The recommended minimum lighting level for cutting and sewing sections is about 500-1000 lux and for finishing section is about 250-500 lux. By providing additional task lighting in the machine for sewing operations the visibility of the needle points can be increased. Replace normal fluorescent lamp to LED tube lights, LEDs are more expensive initially but they consume less power, long term and more durable. Fluorescent tubes produce more heat than LEDs.

The temperature was high in cutting and sewing sections.

- In order to minimize the extent to which the workers are exposed to heat generated from the sewing machine motor, a gap of 4-5 feet between every row of machines has to be maintained.
- The use of local exhaust ventilation systems in hot spots and “spot cooling” through fans to reduce the temperature in certain sections of the factory.
- The use of air conditioners/coolers.
Encourage workers to drink adequate replacement fluids (4 liters/day).

These interventions would help in achieving a safe and healthy workplace environment and in addition would help the organization in seeking certification under international standards like OHSAS 18001.

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CONCLUSION

The present study revealed that the temperature was high in cutting and sewing sections. The illumination level was poor in all the sections though it was numerically within the permissible range. During the study it was also observed that the workers are exposed to cotton dust, poor ventilation and congested work area. Medical records and interactions with the employees indicate that the workers are exposed to health related illness such as heat stress, heat stroke, eye strain, headache, dizziness, etc. Hence, appropriate measures were suggested to improve the environmental parameters which can lead to enhanced occupational health and safety. Further studies can be carried out to analyze other environmental related issues and their influence on the occupational health and safety of the employees in the garment manufacturing units.

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